D 122526 **(Pages : 2)** **Name.....**

Reg. No.....

SECOND SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2025

(CBCSS)

Physics

PHY 2C 05—QUANTUM MECHANICS—I

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

8 Short questions answerable within 7.5 minutes.
Answer **all** *questions, each question carries weightage 1.*

1. What are ladder operators ?
2. What are the necessary and sufficient condition for an operator to be a unitary operator.
3. Distinguish between symmetric wave functions and antisymmetric wave functions.
4. What are Pauli matrices ? Discuss their properties.
5. Calculate the commutator $\left[\hat{X}, \hat{L}x\right]$.
6. Define Hilbert Space.
7. Differentiate between Schrodinger picture and Heisenberg picture.
8. What do you mean by symmetry transformations.

(8 × 1 = 8 weightage)

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each question carries weightage 5.*

9. Discuss the Harmonic oscillator problem in Heisenberg picture.
10. Taking an illustrative example of ground state of the Helium atom, describe the important role played by the symmetry of the wave function in the dynamics of the system.

Turn over

11. What are Hermitian operators ? Show that the eigen values of the Hermittan operators are real and the eigen vectors corresponding to different eigen values are orthogonal.

12. Discuss the formal theory of angular momentum addition. Obtain the expression for Clebsch-Gordan co-efficient.

(2 × 5 = 10 weightage)

Section C

7 *problems answerable within* 15 *minutes.*
Answer any **four** *questions, each question carries weightage* 3.

13. What is time evolution operator ? Obtain the Schrodinger equation for the time evolution operator.

14. Show that the wavefunction of a system of identical particles is either totally symmetric or totally antisymmetric.

15. Determine the matrix elements of ladder operators.

16. Show that the conservation of the linear momentum of a physical system is a consequence of the translational invariance of the Hamiltonian of the system.

17. Obtain the energy eigen values of the isotropic harmonic oscillator using the radial equation.

18. How do you represent the momentum operator in position basis and vice-versa.

19. Calculate the commutator $\left[\mathrm{J}^2, \mathrm{J}_x\right]$.

(4 × 3 = 12 weightage)